Greenway Ecological Standing Committee
Grantee Status Report

Status Report Date: November 23, 2015	
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River: Importance for Sport Fish, Common Terns and Public Education.	
Organization: State University of New York – Buffalo State	
Report Prepared By: Dr. Alicia Pérez-Fuentetaja	
Contact Information: (716) 878-4608, perezfa@buffalostate.edu	
Project Start Date: 01/01/2014	Project Anticipated Completion Date: 05/31/2017

1. Describe what progress you have made toward each of your grant objectives since your last status report. Did you meet your goals for this period? Please be specific.

Objective 1: Locate and quantify the types of habitats preferred by shiners and determine which ones are more important for reproductive success. Examine food resources for juvenile and adult shiners and their trophic position.

In the 2015 sampling season we have continued with the sampling regime that we followed during the field season of 2014 (see our GESC annual report for 2014). Our sampling started on June 8th and ended on October 16th, 2015.

The 2014 and 2015 seasons have been very different in terms of total catch of emerald shiners and the condition of the fish. Based on the mean catch-per-unit-effort (CPUE) between both years, the emerald shiner population has decreased 75% in the upper Niagara River from 2014 to 2015. In the 2014 season, the mean CPUE was 11.9 fish/min. (± 2.9 SE) and in 2015 it was 2.7 fish/min. (± 0.6 SE), using electrofishing gear. This difference between the catch both years is statistically significant (two-tail t-test $p=0.002$) and indicates a marked decline of emerald shiners in 2015 to about one-fourth of the population size of the previous year.

In addition to lower population size, in 2015 the emerald shiners were also showing signs of disease. We sent some specimens to a fish pathologist, Dr. Getchell from Cornell University's School of Veterinary Science, to determine the cause of sickness. A preliminary overview of a set of decalcified emerald shiner slides made from a small sample of diseased fish has revealed that they had inflammation and pathology in the muscle, also one of the fish had myxozoan parasites severely effecting the gills, and another fish had epitheliocystis in the gills. A further sample of 50 diseased emerald shiners that we collected through the 2015 field season have been delivered to Dr. Getchell for further analyses.

The following population dynamics and fish condition is based on shiner data collected in 2014. The 2015 data for these parameters in being analyzed at this time. An estimated 31% of the emerald shiner population in the upper Niagara is in reproductive status and is comprised of fish one-year-old and older (Fig. 1).

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Population Dynamics

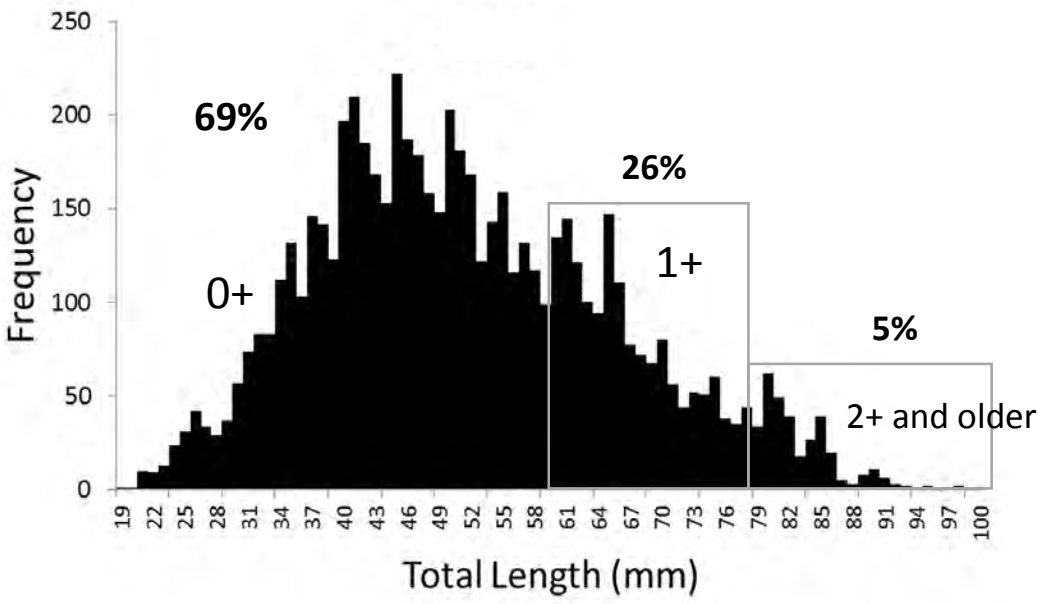

Figure 1. The reproductive population of emerald shiners in the upper Niagara River includes fish above 59 mm total length, usually from ages 1+, 2+ and a few older fish; this is about 31% of the population. The rest (69%) are non-reproductive juveniles.

We are using growth and mortality estimates of emerald shiners to understand their population dynamics. The main objective of this analysis was to estimate seasonal growth and mortality rates from the Upper Niagara River (Fig. 2). We also compared these estimates to other emerald shiner populations, since average or above-average growth relative to other similar populations of the same species is one indicator of overall population health. In addition, we examined the spatial distribution of young emerald shiners to help identify key habitats for early life history stages.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

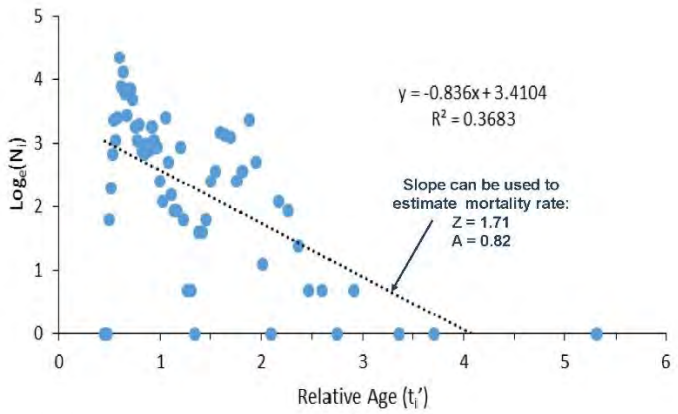

Figure 2. Length-converted catch curve used to estimate annual mortality rates, which are about 82%. In other words, 82% of the emerald shiner population each year dies in the upper Niagara River.

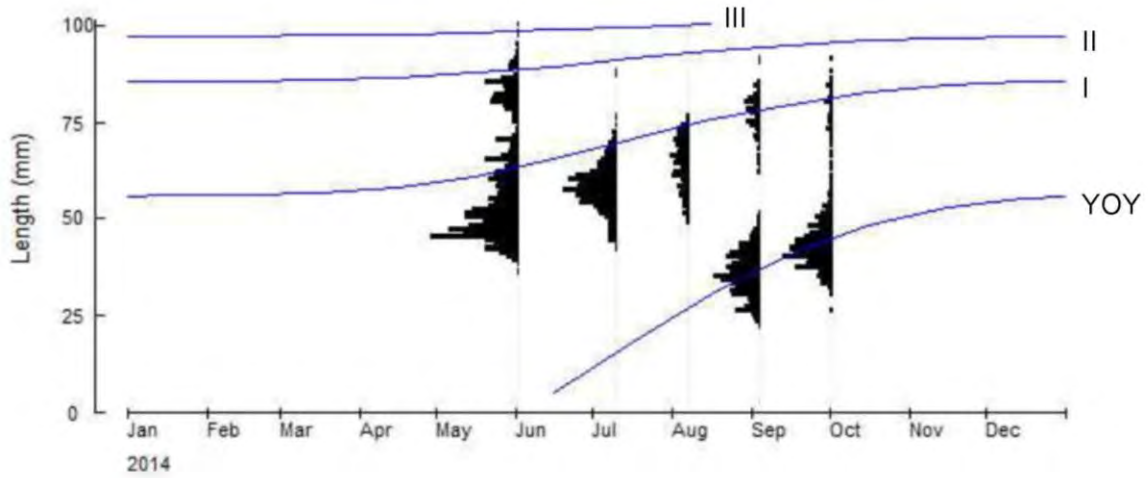

Figure 3. von Bertalanffy growth curves used to estimate growth rates of emerald shiners. The blue lines indicate each age group growing through time.

These results indicate that young-of-the-year fish (YOY) were growing at a rate of 0.20 mm/day and yearlings (age 1) were growing at a rate of 0.23 mm/day in 2014 (Fig. 3). These growth rates indicate that emerald shiners in the Niagara River are achieving 50% of their adult length after one growing season and 80% of their adult length after their second growing season. The growth of emerald shiners in the Niagara River is comparable to those seen in emerald shiners from Lake Simcoe (Ontario) and

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Lewis and Clarke Lake (South Dakota), and exceeds the growth of emerald shiners from Dauphin Lake (Manitoba).

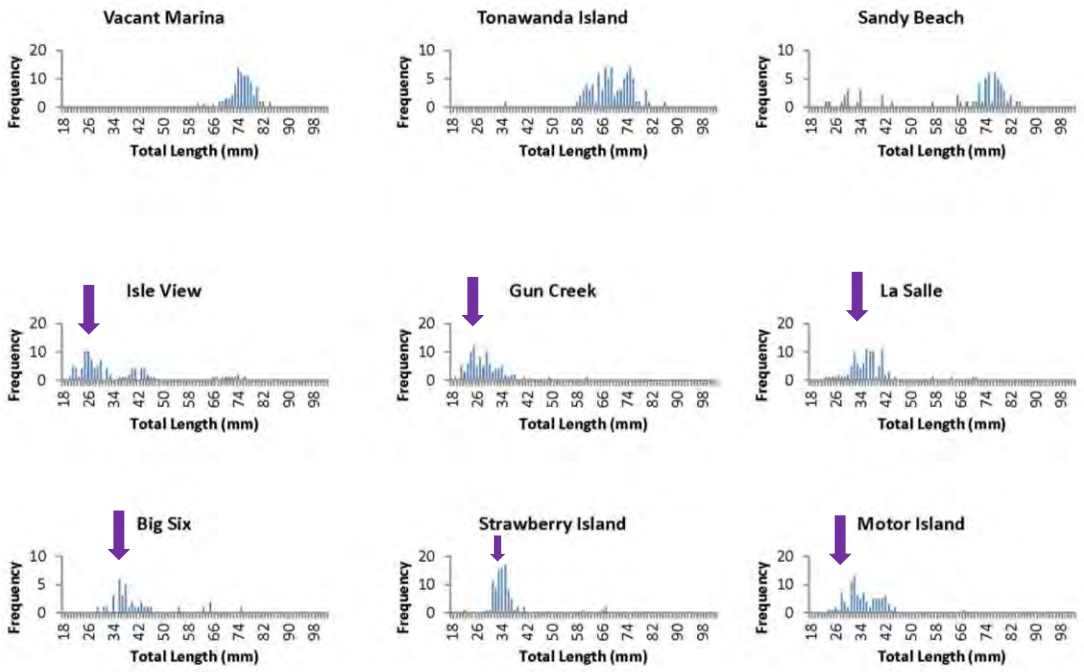

Figure 4. Length-frequency plots showing that YOY emerald shiners first appeared at six sampling sites (Isle View, Gun Creek, La Salle, Big Six, Strawberry Island, and Motor Island) in 2014.

When YOY emerald shiners first appeared in our collections in August 2014, they did not appear at all of our sampling locations. Six sites (Isle View, Gun Creek, La Salle, Big Six, Strawberry Island, and Motor Island) contained large numbers of YOY and virtually no adults, while three other sites (Vacant Marina, Tonawanda Island, and Sandy Beach) contained mainly adults and very few YOY (Fig. 4). Of the six sites containing mainly YOY, Gun Creek and Big Six are river mouths, La Salle and Isle View are located in the main channel of the Niagara River, and Strawberry and Motor Islands are shallow, low-velocity habitats near each of these islands.

Overall, the growth rates in the upper Niagara are relatively high and are similar to several other emerald shiner populations in North America, suggesting that Niagara River emerald shiners are not food-limited. Our study sites differed dramatically in terms of use by early life history stages of the emerald shiner, and these differences will help to guide future recommendations regarding potential habitat restoration projects in the Niagara River.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Population Condition

The overall health of a population of fish is dependent on a suite of characteristics such as the food quality and availability, water quality and cover in the environment they inhabit. Two generally recognized indicators of fish health are their energy content in terms of average calories/gram of whole body weight and their condition factor, which is simply a relationship between length and weight. Viewed in these terms, condition factor and energy content can be used as surrogate measures of suitability of habitat in which a particular fish is found.

As part of the study examining the biology of emerald shiners in the upper Niagara River we were interested in comparing the condition factor and energy content of shiners in the upper Niagara River with those of shiners collected from different habitats in the region. Our goal was to determine the overall suitability of habitat in the upper Niagara River for emerald shiners as compared to other sites. To make these comparisons, we collected adult emerald shiners by boat electrofishing from four sites in Western New York. These locations were the upper Niagara River (UN), eastern Lake Erie (LE), western Lake Ontario (LO) and the lower Niagara River (LN).

Our working hypothesis was that differences in habitat quality may lead to differences in condition factor and/or energy content. Given that emerald shiners were abundant at all of these sites, we assumed that the level of habitat suitability would be such that any differences would be relatively small. We were therefore somewhat surprised by the much higher caloric content of the upper Niagara River shiners (Figs. 5 and 6).

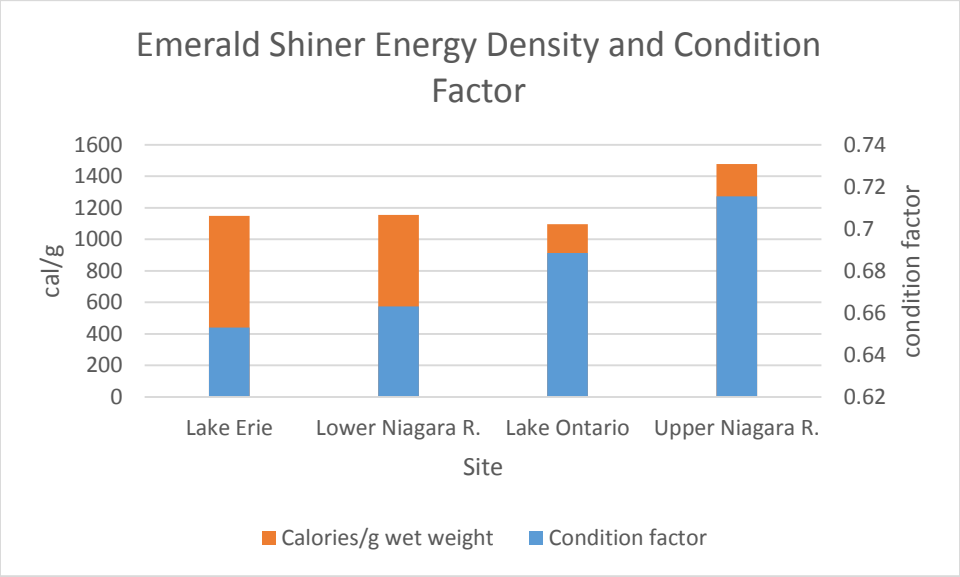

Figure 5. Condition factor and energy density of fish from the four study sites. Condition factor does not seem to be a good predictor of energy density for these sites.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

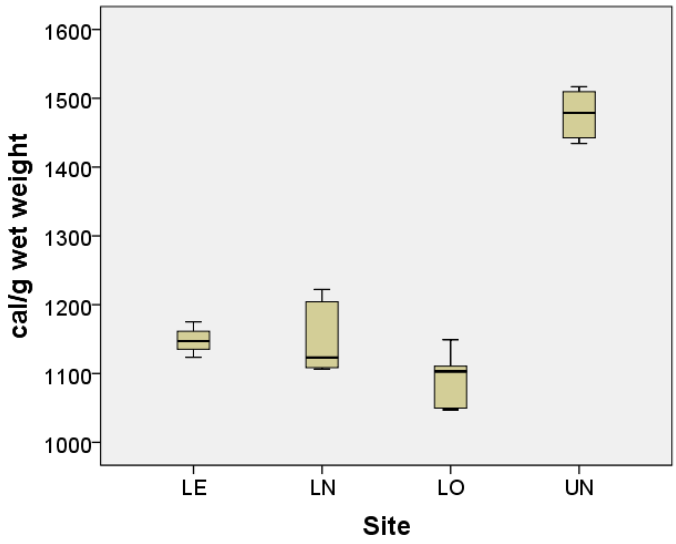

Figure 6. Energy density by site for Lake Erie (LE), Lower Niagara River(LN), Lake Ontario (LO) and the Upper Niagara River (UN). The Upper Niagara fish averaged almost 200 cal/g wet weight more than the fish from the other three sites. The dried ground fish from the Upper Niagara were noticeably oilier than the other fish.

A possible explanation for these results may be that there was a difference in the timing of spawning between the upper Niagara's emerald shiners and shiners from the other sites. If at the time of collection the upper Niagara shiners had not yet spawned, then their fat reserves could be expected to be at a seasonal high, while if the shiners from the other sites had spawned already, then their fat reserves may have been at a seasonal low. In an attempt to address the potential differences in energy content and condition factor due to timing of spawning activity we again collected emerald shiners from the four study sites in 2015, but we have increased our seasonal coverage to three times during the spring and summer of 2015. Calorimetry determinations of these samples will be made during the winter of 2015-2016. It is our expectation that this analysis will allow us to get a more complete picture of energy content and condition of the emerald shiners throughout the season.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Objective 2: Determine if genetic differences exist among populations of emerald shiners in the upper Niagara River, eastern Lake Erie, the lower Niagara River and western Lake Ontario. This knowledge is vital in conservation biology of the species and to design a management plan for the emerald shiner.

Four hundred emerald shiner genetic samples collected in 2014 were analyzed at the Bioinformatics Institute (Virginia Tech) by Dr. Pawel Michalak. Creating the primers for emerald shiners was a new breakthrough for fish genetic analysis. More than 120 microsatellites were identified using bioinformatics, and PCR assays were designed to test 70 of them in the lab. Out of the seventy, 37 gave nice single band PCR products, 6 produced less distinct single/double bands, 20 produced double/multiple bands, and 7 gave no product. See below two gel pictures (Fig. 7). Arrows in the pictures point to good, single bands. Allelic variation in the multiple samples was assessed using a capillary sequencer supporting a DNA fragment protocol. The numbers from polymorphic sites were sufficient to estimate the population genetic parameters.

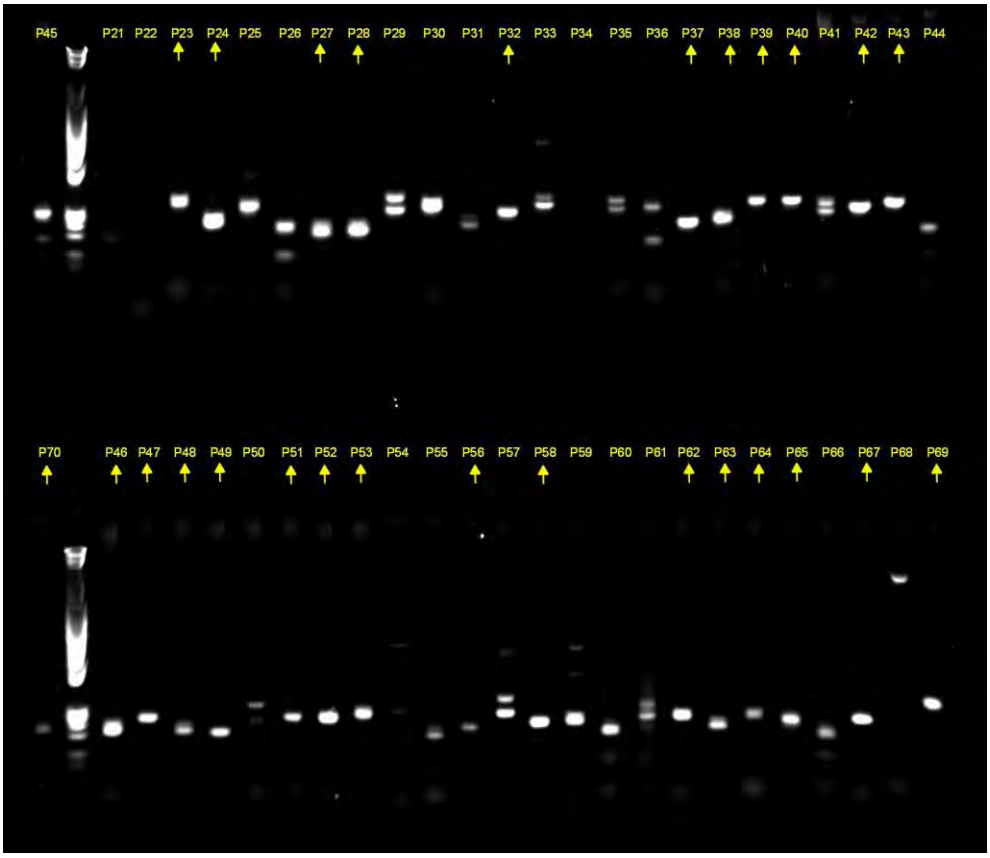

Figure 7. Two gels of emerald shiner DNA from the upper Niagara River with good single bands indicated by yellow arrows.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

To test whether the samples in the data were from structured populations, we ran different methods to analyze the population structure based on the microsatellite data. We first calculated the traditional measurement of genetic distance, fixation index, or F_{ST} for microsatellites. Then we did a Cluster Analysis (Neighbour Joining (NJ) clustering), and we also used the popular sophisticated tool STRUCTURE (multilocus genotype data analysis) to investigate the population structure for the microsatellite data. The inferred structure is given in Fig. 8.

All these analyses indicate that there is no clear genetic structure detected and that more microsatellites need to be included in this analysis and sampling expanded to further regions in the Great Lakes.

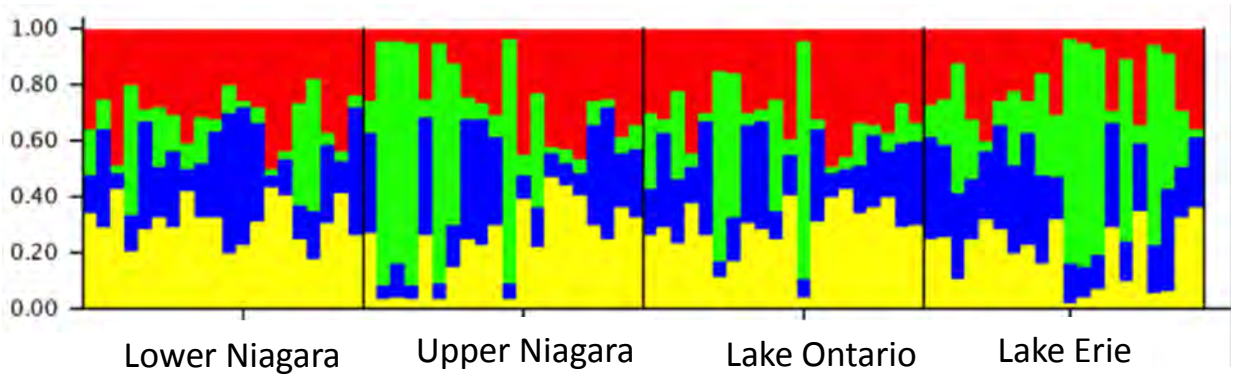

Figure 8. Inferred population structure for the microsatellite data using the sophisticated tool STRUCTURE to investigate it. The four colors indicate the assumed four populations, and the sites where the fish were collected are in the x-axis.

Three are some similarities between the shiners from the upper Niagara and Lake Eire (see larger dominance of green and blue colors), and also of the lower Niagara and Lake Ontario (similar dominance of the four colors).

We have addressed these results by expanding sampling in the 2015 season and by doing morphometric analyses of emerald shiners from the four locations to see whether there are local phenotypic adaptations.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

The 2015 sample collection for genetic analysis is in the following table:

Date, 2015	Location	# shiners
June 15-19	Upper Niagara River Lower Niagara River Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek) Western Lake Ontario (Wilson, NY)	50 50 50 50
July 27-31	Upper Niagara River Lower Niagara River Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek) Western Lake Ontario (Wilson, NY)	50 50 50 50
October 5-9	Upper Niagara River Lower Niagara River Eastern Lake Erie (Mouth of Cattaragus Cr., Silver Creek) Western Lake Ontario (Wilson, NY)	50 50 50 50

Objective 3: Determine water velocities at different locations used by the larvae/juveniles and adults and determine if they pose an obstacle for natural migration patterns using field and laboratory experiments. Analyze the importance of fish barriers and evaluate mitigation measures on fish passage. Design alternatives to these barriers (USACE).

Under the grant obtained by the Buffalo State team from the Great Lakes Remedial Action Plan Program (EPA) to support this project, various studies have taken place to determine flow rates in the upper Niagara River. So far, two Master's thesis have been defended by students at the University at Buffalo that include measurements and modelling efforts to identify hydraulic obstacles to emerald shiner movement between the river and Lake Erie. In addition, another three UB students (PhD in Engineering) are working on determining shiners' swimming speed in a laboratory setting and modelling how fish respond to the stimuli from the river flow.

For the purpose of this annual report, I have included the abstracts of the theses on river flows. These theses are available and manuscripts for publication are currently under preparation.

Allen, I. 2015. Hydrodynamic modeling of the upper Niagara River to assess aquatic connectivity of the emerald shiner (*Notropis atherinoides*) population. M.Sc. Thesis, Dept. of Civil, Structural, and Environmental Engineering, University at Buffalo. Thesis Committee S.K. Delavan, J.F. Atkinson, A. Pérez-Fuentetaja. June 30, 2015.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Anthropogenic modifications at the head of the Niagara River attributed to land reclamation and the installation of seawalls have altered the river channel, leading to increased water velocities and reduced availability of aquatic habitat. As a result of the increased velocities, concerns have been raised that habitat connectivity of the emerald shiner (*Notropis atherinoides*), a key forage species for sport fish and threatened avian species, has been reduced between Lake Erie and the upper Niagara River. In this study, the influence of water velocity stressors on emerald shiner connectivity was assessed by identifying hydrodynamic barriers to upstream fish movement. Using a 2-D hydrodynamic model, velocities in the river were simulated for the 10th, 50th and 90th annual percentile water levels. For each simulation, the locations of potential barriers to movement were evaluated using a least-cost path analysis, swim curve theory outlined in Brett (1964), and the results of three swim tests performed on the emerald shiner by other authors. Results indicate several distinct patterns. First, large velocities immediately downstream of the Peace Bridge crossing (in excess of 2.0 *m s-1*) restrict emerald shiner movement to within close proximity of either shoreline. Second, several potential barriers exist along both the U.S. and Canadian shorelines, the largest of which were located along the vertical seawalls on either side of the river. The extent of each identified potential barrier fluctuated slightly with water level, but the location generally remained consistent. Finally, a comparison of the model results to field measurements of water velocity taken in close proximity of both shorelines shows that of the barriers identified at the scale of the model, the seawall along Broderick Park is the most substantial impediment to upstream movement, as velocities close to the shoreline remain in excess of shiner swimming ability for nearly 200 meters. Future work including empirical estimates of passage success and swimming tests on shiners native to the Niagara River will help determine if remediation work is warranted to facilitate upstream passage at the identified impediments.

Sood, S. 2015. Turbulence and velocity barriers to upstream emerald shiner (*Notropis atherinoides*) movement: a field study at Broderick Park, Buffalo – NY. M.Sc. Thesis, Dept. of Civil, Structural, and Environmental Engineering, University at Buffalo. Thesis Committee S.K. Delavan, J.F. Atkinson, A. Pérez-Fuentetaja, S.J. Bennett. September 22, 2015.

Physical modifications near the head of the upper Niagara River in the form of river dredging and construction of vertical seawalls are assumed to have resulted in the channelization of the river leading to increased water velocities and modified turbulence conditions along the shorelines. These changes have presumably impacted the emerald shiners (*Notropis atherinoides*), a small pelagic minnow that is a key forage species in the local ecosystem. Emerald shiners have been observed to congregate downstream of a shoreline recess at Broderick Park and the goal of this study was to identify if the Broderick Park shoreline posed a substantial impediment to their upstream movement. Water velocity measurements were collected along the Broderick Park Seawall and the Bird Island Pier using an

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Acoustic Doppler Velocimeter and an Acoustic Doppler Current Profiler to quantify the existing hydrodynamic conditions along the shoreline. The results indicate that the vertical seawall located upstream of the recess is characterized by water velocities that exceed 1 *m s-1* and are beyond the known emerald shiner critical swimming speed of ~ 0.59 *m s-1* (Jones et al. 1974; Young 2001). Also, flow turbulence, quantified in terms of turbulent kinetic energy (TKE) and Reynolds shear stress, is the largest upstream of the shoreline recess. The large turbulence values suggest that the emerald shiners may experience disorientation and body damage while moving upstream past this region. Finally, the vertical seawall upstream of the shoreline recess is also characterized by a large number of eddies within a problematic size range for emerald shiners (0.055 – 0.4 *m*) that could potentially cause a reduction in their critical swimming speed due to overturn and imbalance. In contrast, the regions downstream of the recess and along the Bird Island Pier are characterized by (a) water velocities that are mostly within the emerald shiner critical swimming speed of ~ 0.59 *m s-1*; (b) smaller magnitudes of TKE and Reynolds shear stress; and (c) sizes of eddies that typically lie outside the problematic size range for the emerald shiners. Therefore, it is concluded from this study that the Broderick Park Seawall located upstream of the shoreline recess poses the greatest impediment to the emerald shiner movement along the modified US shoreline of the upper Niagara River.

We are currently testing the emerald shiners' swimming speed in various laboratory settings (UB-PhD student K. Vorenkamp). The results from the trials performed so far are below. At this time only individual fish have been tested, i.e., one fish per trial.

The fish were placed in a swim tunnel that itself was placed inside a recirculating water flume (Figure 9). The shiners were acclimated to the water, then the water flow was gradually increased to the target velocity, which for these tests ranged between 10 and 70 cm/s. Once the target velocity was reached, the fish was monitored until it failed to maintain its position, or 60 minutes had passed. If failure occurred, the fish was given a recovery period of two minutes at zero flow and then retested at the target velocity. Water parameters in the holding tank and flume, including temperature, dissolved oxygen, pH, and conductivity were recorded prior to and after each trial. Post-trial, the physical measurements of each fish were taken including total length, standard length, fork length, upper caudal lobe length, and body weight. In addition, general fish behavior was noted and video recordings were made for select experiments. Preliminary results are shown in Fig. 10.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

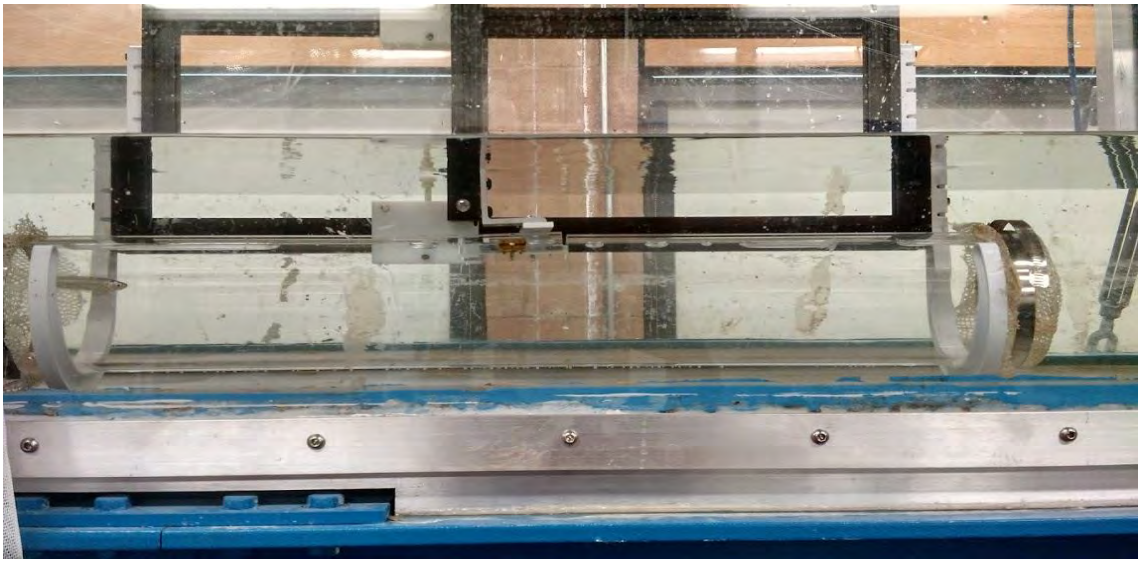

Figure 9. Swim tunnel placed in a recirculating flume.

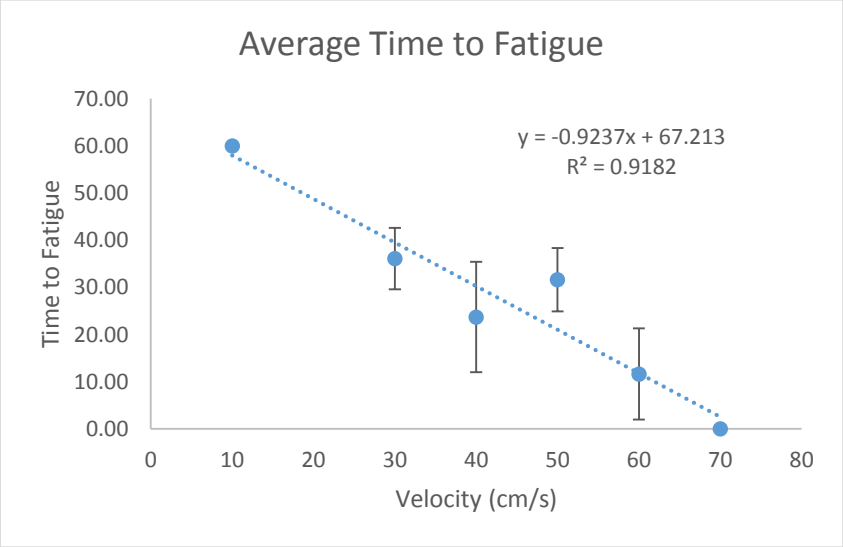

Figure 10. An average time to fatigue was calculated for each water velocity for healthy emerald shiners that did not exhibit stress symptoms during the acclimation period. Based on the regression line, the linearly projected maximum velocity is 72.77 cm/s. However, no fish was observed to swim above 70 cm/s.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Several attempts were made to determine if there were any correlations between time to fatigue and other characteristics of the fish. First, the data were evaluated to compare fish length to time to fatigue in order to ascertain whether success might correlate to age of the fish (assuming age and fish length are comparable measures). Overall, shiners smaller than 40 mm were not able to swim for the entire 60 minute trial, while many shiners 50 mm and larger were able to maintain swimming activity for the entire duration (Fig. 11).

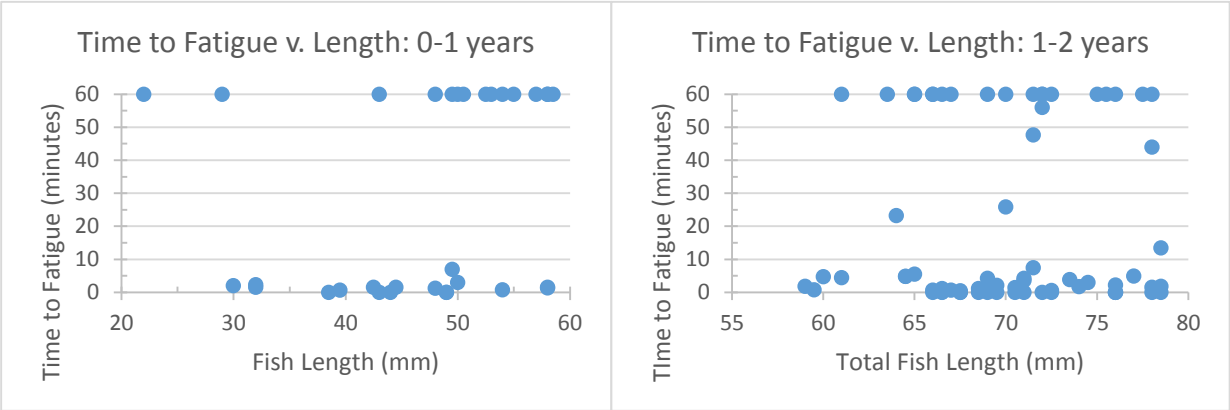

Figure 11. There is a noticeable difference in the swimming capability of fish in the 0-1 year class and in the 1-2 year class, with younger fish having less developed swimming ability.

The upper Niagara River water velocities often exceed 100 cm/s (1m/s), therefore, the observations reported here suggest individual emerald shiners would not have the swimming capacity to navigate upstream from the river into Lake Erie. Any conclusions made at this time, however, should be considered preliminary as this work is in progress. Based on current observations, it appears that the top swimming speed for these fish is between 60 and 70 cm/s, and that larger (older) fish can generally swim faster than smaller (younger) fish. Future work will focus on improving our estimate for the critical swimming speed for the emerald shiner by conducting additional individual swim trials. In addition, we will begin to evaluate how fitness contributes as a covariate to swimming performance, since fish fitness is likely driving the success rate. To determine fitness, standard fish metrics that incorporate morphometric measurements will be used. Finally, the effect of schooling behavior to overcome higher velocities will be evaluated, and the fluid dynamics of individual and schooling swimming behaviors will be quantified.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Objective 4: Study sport fish consumption of emerald shiners and determine the importance of shiners in their diet in the upper Niagara River. Likewise, study common tern consumption of shiners and what they feed to their chicks by trophic position determination.

One hundred and fifteen potential predators of emerald shiners have been collected during the field season of 2015 in the upper river using electrofishing gear and hook and line. Some fish, such as Rudd, were collected to determine if they fed on juvenile emerald shiners as part of their omnivorous diet.

Predator Fish	**Number**
Bowfin ……	3
Largemouth bass ……	15
Muskellunge (stomach lavage only, fish released)	1
Northern Pike (stomach lavage only, fish released)	3
Rock Bass ……	6
Rudd ……..	8
Smallmouth Bass ……..	16
Steelhead trout ……..	13
Walleye ……	17
White Bass ……..	17
White Perch ……..	1
Yellow Perch ……..	15
Total	**115**

Examination of the predator stomach contents collected is still in progress, however, we have some results for two main predatory species, steelhead trout and walleye. The following results show the great importance of the emerald shiner in the diet of these economically relevant sport fishes (Figs. 12 and 13).

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

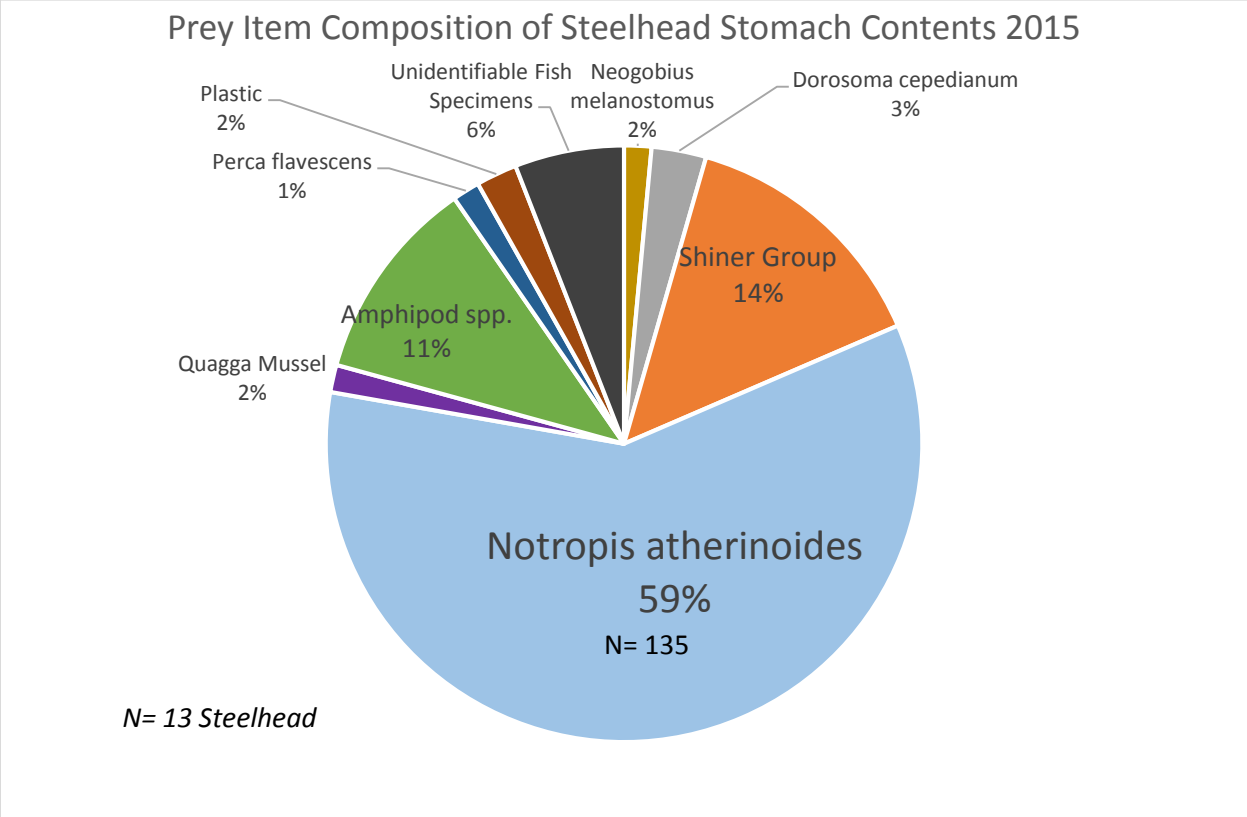

Figure 12. The diet of 13 steelhead analyzed for this project show that 73% of the stomach contents were shiners. Fifty nine percent were confirmed emerald shiners, and the remaining 14% were partially digested and not identified to species (in chart shown as "shiner group").

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

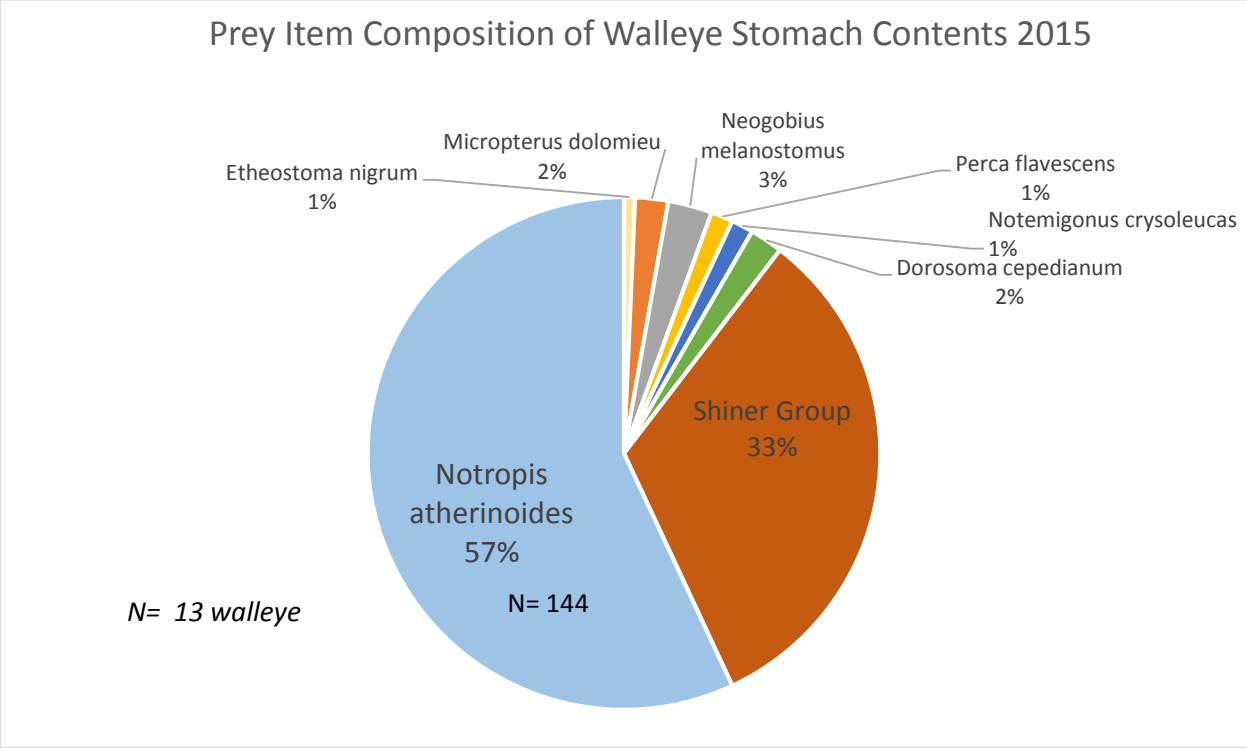

Figure 13. In the diet of 13 walleye examined, we found that 90% of their stomachs had shiners. Fifty seven percent were identified as emerald shiners and 33% were partially digested (shown as "shiner group").

We are currently waiting for the results from the Colorado Plateau Stable Isotope Laboratory (analysis of ^{13}C and ^{15}N), on the trophic status of the fish predators, emerald shiners and common tern adults and chicks (the birds are animals that perished of natural causes in 2014, NYSDEC). During 2015, no dead adult or chick common terns were collected due to colony failure during this season (C. Adams, NYSDEC, *personal communication*).

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Objective 5: Identify key emerald shiner habitat, including mouths of tributaries and bankside vegetation. Develop a conceptual plan for habitat restoration for key habitats (in coordination with other habitat restoration projects underway by USACE, USFWS, NYSDEC, and Buffalo Niagara Riverkeeper).

We have sampled a variety of habitats in the upper river for adult and larval emerald shiners to determine what types of habitats are preferred by each life-stage. Fish larvae of many river-dwelling species (including emerald shiners) were particularly abundant in nursery habitats dominated by vegetation. Tiny larvae that had just come out of the yolk-sac stage were also found in marinas in 2014 and 2015, although mostly they were unidentifiable to species due to their lack of distinguishable characteristics at that early stage. The family and Cyprinidae composition of the larvae collected in 2014 are shown in Fig. 14 and their preferred habitat in Fig. 15. We are currently identifying the fish larvae collected in 2015.

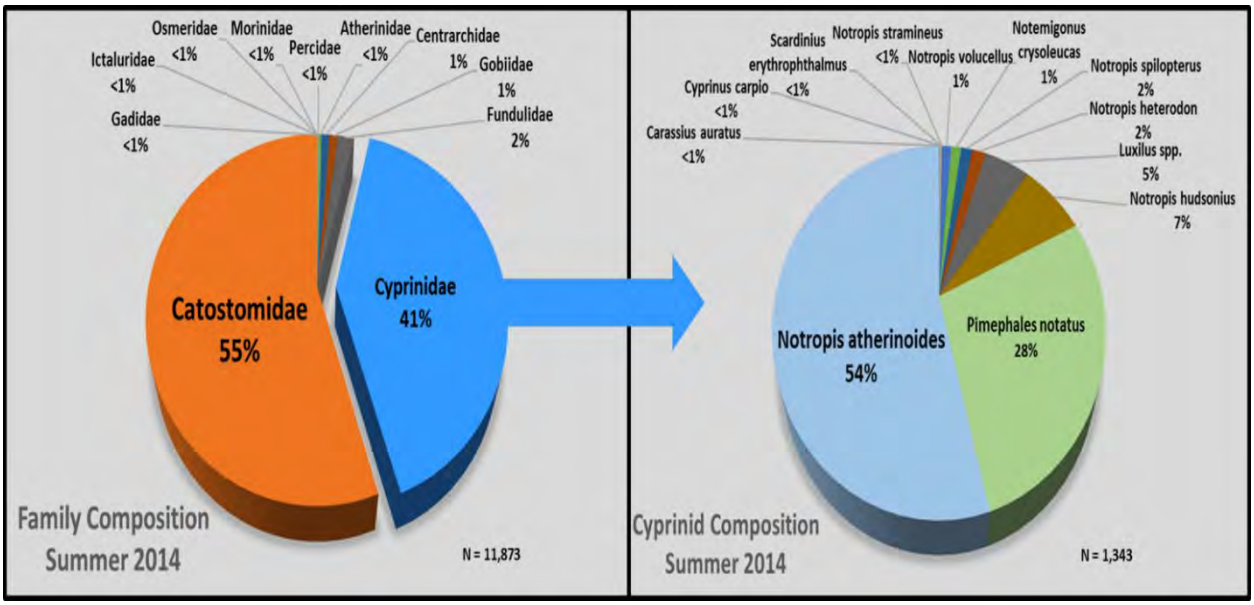

Figure 14. Of all the larvae collected in the 2014 field season, 41% were Cyprinidae and of those larvae 54% were emerald shiners.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

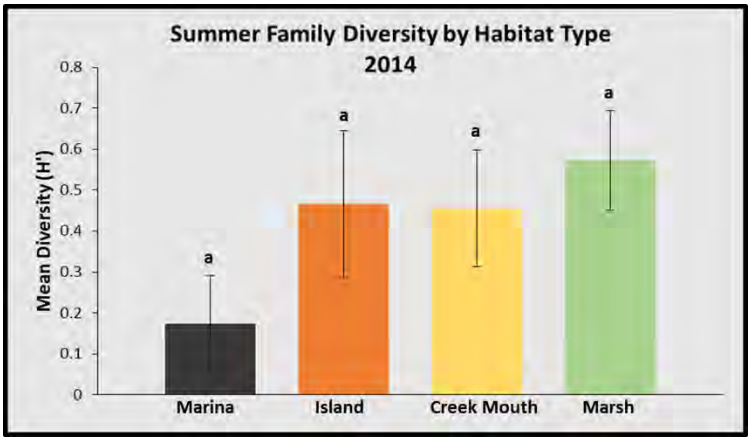

Figure 15. We found larvae and young-of-the year (YOY) cyprinids in four habitats: marinas, islands (Strawberry I., Motor I., Beaver I.), creek mouths and marsh areas. Although the mean diversity of cyprinid juveniles was not significantly different among these habitats (see same letter on top of columns, $p>0.05$), marinas had the lowest mean diversity of these larvae and emergent marshes had the highest fish diversity.

The conceptual plan for habitat conservation or restoration that is part of this pobjective will be developed in year 2016.

Objective 6: Characterization of nearshore plant communities in key emerald shiner habitats, supplementing both existing data collected and new data being developed by Buffalo Niagara Riverkeeper as part of their ongoing Niagara River Habitat Conservation Strategy. Create a habitat quality index for the emerald shiner in the Niagara River to compare the status of different habitats in the river for shiner recruitment.

The characterization of nearshore plant communities was undertaken in summer 2015 at twelve sites (Sandy Beach Marsh, Spicer Creek, Strawberry Island, Motor Island, Mouth Big Six Mile Creek, Burnt Ship Creek, Marina at LaSalle Yatch Club, Marina at Ellicott Creek, Marina at Black Rock Canal, Marina at Beaver Island, Marina at Big Six Mile Creek, and the vacant Marina, see map, Appendix). We used various methods to determine plant composition and coverage. Using a Lowrance HDS Sonar and the mapping software BioBase, we mapped the depth, substrate hardness and macrophyte biovolume at each site (see Appendix "USACE Activity Report 2015").

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

A point-intercept sampling plan was developed for each site and the following data was collected at each point: macrophyte species presence and abundance data was collected via rake tosses (Fig. 16); flow velocity and direction was collected with an Acoustic Doppler Velocimeter (ADV) and substrate characterization was determined taking sediment samples with a Peterson Surface Grab Sampler. The data collected at each point intercept will be overlayed upon the site maps created with the data from the sonar, to provide a more detailed habitat characterization of each site. At select locations in all the sites, plants were collected for periphyton characterization and water quality measurements were taken.

Figure 16. Graduate student (S. Fleck, Buffalo State) collecting macrophytes with rake for identification.

The creation of a habitat quality index for the emerald shiner in the Niagara River to compare the status of different habitats in the river for shiner recruitment is one of the goals of year 3 and will be undertaken in 2016.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Objective 7: Develop materials for education and outreach in collaboration: videos, talks to interested groups and schools. Include groups traditionally excluded from environmental decision-making.
In addition, provide a Geographic Information Systems (GIS) map with information on habitat use by emerald shiners to interested parties for management and restoration purposes.

A new education specialist was hired for this second year of the project, Jo Johnson. She is also a M.A. graduate student at Buffalo State and she is doing her thesis in this project, so she has a direct connection with our activities in the river. Besides outreach and talking to fishermen and other river users, Jo has created and maintains a webpage for the project (http://emerald shiner.buffalostate.edu) as well as Twitter, Facebook (https://www.facebook.com/emeraldshiners) and Instagram accounts to communicate our activities to the educators and the greater public in Buffalo and elsewhere. She has been assisted by the Buffalo-Niagara Riverkeeper. A report of their activities during this last year can be found in the Appendix.

The development of the GIS map will be an important part of the 2016 goals.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

2. How did you measure your progress since your last status report? What kind of data have been collected to determine whether progress is being made or not being made? What results have been obtained since your last status report?

We have made excellent progress in meeting all of our objectives. The greater part of the field collections for this project have been made during the field seasons of 2014 and 2015. Laboratory samples have been analyzed for 2014 and we are now processing the samples from 2015.

Our graduate students' thesis work is also enhancing our understanding of the population biology of the emerald shiner in the upper Niagara, as well as the functioning of the ecosystem as a whole.

Student/Graduate Program at Buffalo State	**Title or Topic of Master's Thesis Research**
Jacob Cochran (completion date 5/31/15) GLES-MA	Title: Ecology of the Young-of-the-Year Emerald Shiner (*Notropis atherinoides*) in the Upper Niagara River: Development, Growth, and Assemblage Interactions.
Chris Osborne (completion date 5/31/15) BIO-MA	Title: Assessing Reproductive Effort of the Emerald Shiner (*Notropis atherinoides*) in the Upper Niagara River: effects of age, sex, and seasonality.
John Lang (completion date 5/31/15) BIO-MA	Title: An Analysis of Morphometric and Genetic Differentiation in Lake and River Populations of the Emerald Shiner, *Notropis atherinoides.*
Steven Fleck (start date 1/1/15) BIO-MA	Title: Diet and Habitat Choice of Larval Fish in the Macrophyte beds of Niagara River Wetlands.
Rebecca Johnson (start date 6/1/15) GLES-MA	Topic: Microbiology and water chemistry of habitats utilized by larval and juvenile emerald shiners in the upper Niagara River.
Colleen Kolb (start date 8/31/15) GLES-MA	Topic: Use of fatty acids and stable isotopes to investigate the diet of the emerald shiner in the Niagara River.

In addition, two Master's thesis in Engineering have been completed and defended at UB for this project and three other students are focusing their PhD theses on questions posed by river flows in the Niagara and fish's adaptations and limitations to overcome them (see question 1, objective 3).

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

3. What challenges have you encountered since your last status report? How are you addressing these challenges?

The only important challenge we experienced during this period was the withdrawal of our collaborator at UB. Dr. Delavan left her academic position at UB and moved to another state. She had been subcontracted by the Remedial Action Plan grant for this project (administered by USACE) to study river flows and the swimming abilities of the emerald shiner. The University at Buffalo found suitable replacements: Dr. Joseph Atkinson (Dept. of Civil, Structural and Environmental Engineering) and Dr. Sean Bennet (Dept. of Geography) who have joined the project. We are happy to report that our collaboration with Drs. Atkinson and Bennet is excellent and this aspect of the project is progressing very well.

4. Are you on schedule to complete your project in the proposed timeline? If not, please explain why you are ahead or behind schedule.

We are on schedule to end this project by May 31, 2017 as indicated in our previous annual report (2014) due to a misalignment of the academic and the annual schedules.

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

5. Please use the table below to report your expenditures since your last status report. Include in-kind support from other resources have you used since your last report below the table. Please explain any differences between anticipated and actual expenditures. Attach copies of any relevant receipts or invoices to this report.

Period November 2014 - October 2015

Budget Categories	GESC-approved Budget	Funds or In-kind Support from Other Resources	Total Expenses to date	Remaining Balance
Salaries and Benefits	137,203.00	29,572.49	124,112.17	13,090.83
Travel	5,000.00	18,050.00	4,911.13	88.87
Equipment				-
Supplies	12,093.00		7,368.83	4,724.17
Meetings				-
Printed Material				-
Contractual	48,200.00		59,363.76	(11,163.76)
Consultants	6,970.00			6,970.00
Other		23,028.15	811.28	(811.28)
Tuition and Fees	40,000.00		42,047.23	(2,047.23)
Total Funds	249,466.00	70,650.64	238,614.40	10,851.60

NOTE: Matching cost in Other category are for indirect costs on match salary and fringe benefits, and waived indirect costs on project expenditures.

YEAR 1 & 2 CUMULATIVE Jan 2014 - Oct 2015

Budget Categories	GESC-approved Budget	Funds or In-kind Support from Other Resources	Total Expenses to date	Remaining Balance
Salaries and Benefits	269,650.00	57,043.91	201,668.06	67,981.94
Travel	5,000.00	18,050.00	5,194.83	(194.83)
Equipment				-
Supplies	29,093.00		12,081.48	17,011.52
Meetings				-
Printed Material				-
Contractual	82,400.00		70,407.92	11,992.08
Consultants	13,720.00			13,720.00
Other	22,307.00	51,488.52	5,362.65	16,944.35
Tuition and Fees	73,000.00		55,241.89	17,758.11
Total Funds	495,170.00	126,582.43	349,956.83	145,213.17

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

The extra funds in the cumulative expenditure budget above are due to a time misalignment between the annual funding period and the project seasonal dynamics, i.e., the field season starts in late Spring, when most of the personnel salaries start. In particular, this affects the salaries of students. Because the funds come to us from January 1-Dec. 31, we request that the remaining funds be forwarded for use until May 31, 2017. This will require an extension of the grant.

6. What progress toward your objectives do you expect to make before your next status report? Please be specific.

Our next report will be our final report. By then, we expect to have completed all the data processing and have graduated the students from the Buffalo State portion of this project, we also expect the first publications from this project to start appearing in peer-reviewed journals. During 2016 our focus will be on the integration of the data collected on the Niagara River ecology and the emerald shiner population into a Geographic Information Systems platform that includes habitat metrics, river biology, and physico-chemical characteristics. We also expect to have designed the first engineering products to remedy or ameliorate the effects of vertical bulkheads on water velocity for areas where there is a hydraulic barrier for natural emerald shiner (and other aquatic species) movement upstream from the upper Niagara into Lake Erie.

7. Please include 1 to 2 photographs with dates and short descriptions taken since your last project report.

See attached in Appendix an article on the project with photos and statements from the current graduate students working with emerald shiners at Buffalo State. This article has been published in the Buffalo State Great Lakes Center Newsletter from Fall 2015. The photographs are from summer 2015 and are in a file sent to Greenway (Mr. Tim DePriest) with this report as "ESHINER_Attachment_2.pdf"

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State

Appendix

List of Attachments:

1. Map of sampling sites (in this document, next page).

2. GLC newsletter excerpt with article about project by students and project photos. (file: ESHINER_Attachment_2. pdf)

3. Report from in-kind activities and matching-funds budget by USACE (file: ESHINER_Attachment_3.pdf)

4. Outreach activity report: Buffalo State and Buffalo Niagara Riverkeeper (file: ESHINER_Attachment_4.pdf)

Status Report Date: November 23. 2015
Project Title: Emerald Shiner Habitat Conservation and Restoration Study in the Upper Niagara River
Organization: State University of New York – Buffalo State